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Indigenous knowledge for climate change adaptation among Tanzanian smallholder farmers: A systematic review

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Abstract

This study investigates the use of Indigenous knowledge for climate change adaptation and mitigation among smallholder farmers in Tanzania. It adheres to the PRISM (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The study includes 20 peer-reviewed articles published between 2004 and 2023. The findings show that Indigenous knowledge is acquired from various sources, including personal experience, parents, friends and community members. Elders are key custodians of Indigenous knowledge. Smallholder farmers employ various techniques to adapt to and mitigate the impacts of climate change, including mixed farming practices, crop diversification, the use of traditional water dams, prayer and cultural rituals, participating in non-farming activities, entrepreneurship and the use of locally made pesticides. The findings imply that Indigenous knowledge has the potential to solve contextual-based problems. This review recommends further research to document Indigenous knowledge of climate change adaptation across all regions and ethnic groups in Tanzania.

Keywords

Indigenous knowledge, climate change adaptation, smallholder farmers, Tanzania, local knowledge

Introduction

Indigenous knowledge refers to the information, expertise, skills and insights that Indigenous communities acquire during their lifetime and use in solving problems such as climate change, food insecurity, diseases and other social issues (Tweheyo et al., 2024). Indigenous knowledge is an important resource for the development of human society across the globe. Throughout history, different communities have depended on the Indigenous knowledge that has been developed and used by one generation and passed down to the next in all aspects of their lives, from health to climate change adaptation, food security and agriculture (Mugi-Ngenga et al., 2021). Indigenous knowledge is developed consistently and continuously based on the changes occurring in the surrounding environment. It is part of people's culture, norms and traditions, and hence passed down from one generation living in a particular place to the next (Irumva et al., 2021). It is social capital in a resource-constrained environment, and communities use it to survive, adapt to and mitigate climate change, and provide a means to control their lives (Nkuba et al., 2021).

With the global existential threat from climate change, both types of knowledge meaning scientific and indigenous knowledge are blended to enhance climate change

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adaptation and mitigation (Kihila, 2018). Climate adaptation strategies involve different means and resources, such as the integration of climate action into national and regional policies (Shirima et al., 2018). Local farmers have developed indication and warning systems that help them detect changes early and respond to them appropriately (Mapfumo et al., 2016). Farmers and pastoralists use several plant and animal behaviours as early warning signs. In South Africa, smallholder farmers use modified farming practices, crops and animal types, as well as Indigenous knowledge systems, to ensure flexibility and adaptability – for example, goats giving birth in April indicates the onset of rains and the appearance of small white butterflies indicates an invasion of armyworms in coming agricultural season (Kuivanen et al., 2015).

Smallholder farmers and pastoralists must deal with the outcomes of the changing climate, such as floods, droughts, infestations of climate-related pests, the unpredictability of rainy seasons, poor crop yields and food insecurity. Agricultural-dependent communities are one of the groups that are most affected, not only because of their over-dependence on rainy seasons to conduct their agricultural activities but also because they live in resource-constrained environments (Pickson and He, 2021). Living in a resource-constrained environment makes it even more complicated to adapt to the changing climate and mitigate it effects (Joseph, 2022). Due to limited access to scientific knowledge and weather-forecasting technology, smallholder farmers use animal behaviours, the changing direction of the wind, and insect and plant behaviours to predict and prepare for the changing weather and climate (Theodory, 2020). This study systematically reviewed the use of Indigenous knowledge to enhance climate change adaptation and mitigation among smallholder farmers in Tanzania. The study answers the following research questions:

1. What are the sources used to acquire Indigenous knowledge for climate change adaptation and mitigation among smallholder farmers?
2. What are the Indigenous climate change indicators and how are they interpreted among smallholder farmers?
3. What are the Indigenous adaptive and mitigation practices for climate change among smallholder farmers?

Methodology

The study used a qualitative methodology. Specifically, the systematic review method was used, with thematic and content analysis techniques to review the selected studies. The study included peer-reviewed articles published in a variety of online journals. The studies selected cover the use of Indigenous knowledge for climate change adaptation and mitigation. The subsequent sections of this article explain the data collection method, as well as the methods used for the appraisal of the information obtained during the search in Google Scholar, JSTOR and ScienceDirect. The selected publications broadly elaborate on various aspects addressing Indigenous knowledge and climate change in Tanzania. The areas highlighted include the sources of Indigenous knowledge for climate change adaptation, as well as Indigenous indicators of climate change and their interpretation among smallholder farmers in Tanzania. The study follows the PRISM (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Dorji et al., 2024; Figure 1).

Inclusion and exclusion criteria

Several studies were examined based on the following inclusion criteria: articles published between 2004 and 2023 (the range of years was selected based on the availability of peer-reviewed articles published on the topic); articles written in the English language; articles covering regions of Tanzania; and articles addressing Indigenous knowledge for climate change adaptation and mitigation. The exclusion criteria were articles published in other languages and articles that did not address Indigenous knowledge of climate change in Tanzania.

Quality assessment

Quality assessment is a crucial factor. A quality evaluation checklist of seven questions was prepared and used to assess the quality of each article ($N = 20$). The answer to each question was rated on a 3-point scale (*yes* = 1, *no* = 0, *partially* = 0.5). Each study can therefore have a score from 0 to 7, and a higher score indicates that the study answered more of the research questions. In this context, it is evident that all of the selected articles passed the quality assessment, meaning that they were eligible for further analysis. The quality assessment checklist was as follows:

1. Are the research objectives/questions outlined?
2. Does the study explain the relationship between Indigenous knowledge and climate change adaptation and mitigation in Tanzania?
3. Are the methods indicated and well outlined?
4. Does the study explain Indigenous adaptive and mitigation practices for climate change among smallholder farmers in Tanzania?

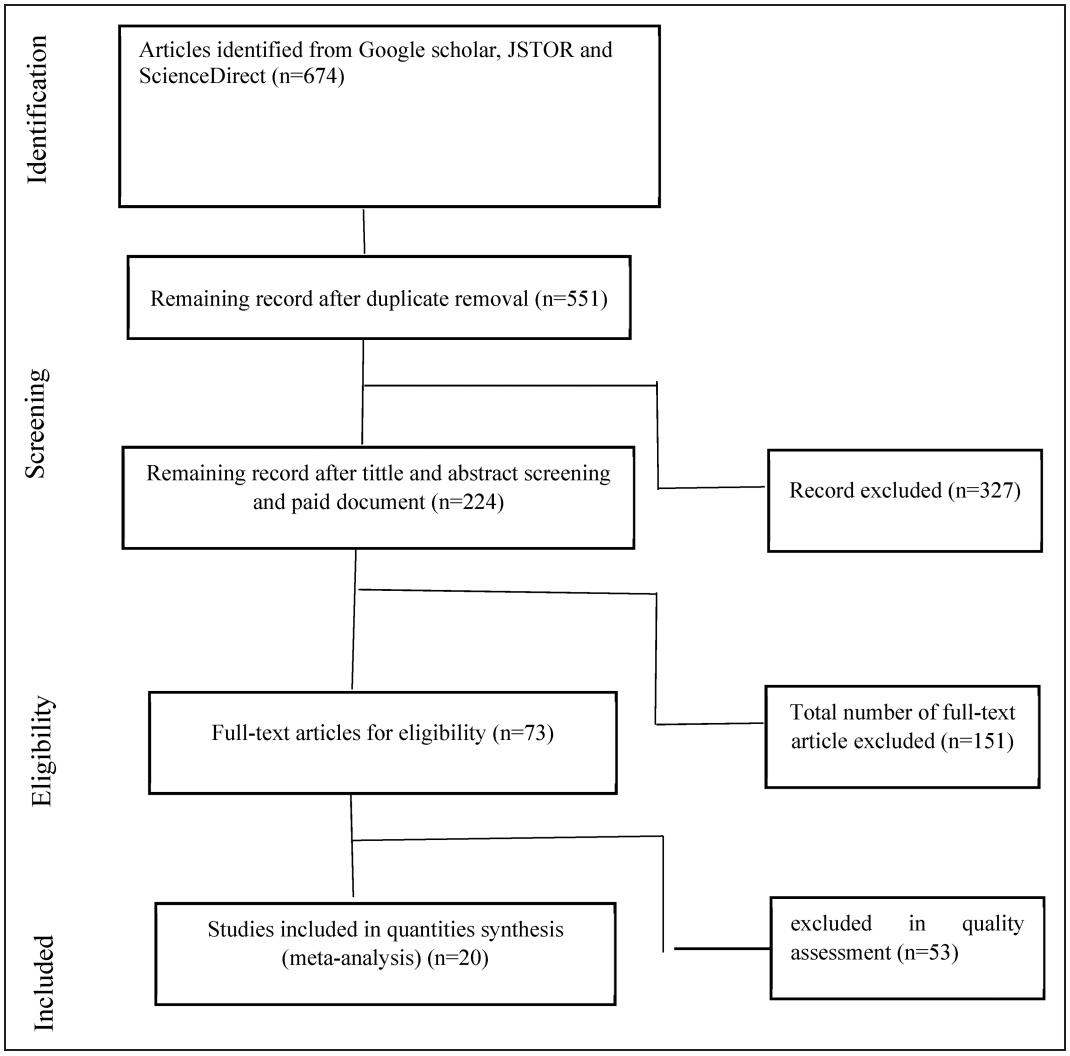

Figure 1. The PRISMA flow chart for the article-selection strategy.

5. Does the study explain Indigenous climate change indicators and their interpretation among smallholder farmers in Tanzania?
6. Does the study explain the sources of Indigenous knowledge related to climate change adaptation and mitigation in Tanzania?
7. Are the statistical techniques for the data analysis described and illustrated?

The search

Searches were conducted in Google Scholar, JSTOR and ScienceDirect using the following keywords: Indigenous knowledge, local knowledge, traditional knowledge, climate change, weather forecasting knowledge, weather forecasting information, smallholder farmers, Indigenous climate knowledge, floods, drought, climate change adaptation and weather changes. The search process used different techniques, including Boolean operators and truncations to maximize the results and retrieve peer-reviewed articles on the study topic.

Data collection and extraction methods

The data was extracted using the paper-form method, with four columns. The first column included the author and year of publication; the second, the title of the article; the third, the key findings; and the fourth, the location where the article was published (Schmidt et al., 2021; see Tables 1, 2 and 3).

Results and discussion

Findings

The articles focus on various dimensions of Indigenous knowledge across various settings in accordance with climate change adaptation and mitigation among smallholder farmers in Tanzania. The findings presented in Tables 1, 2 and 3 give important information about the

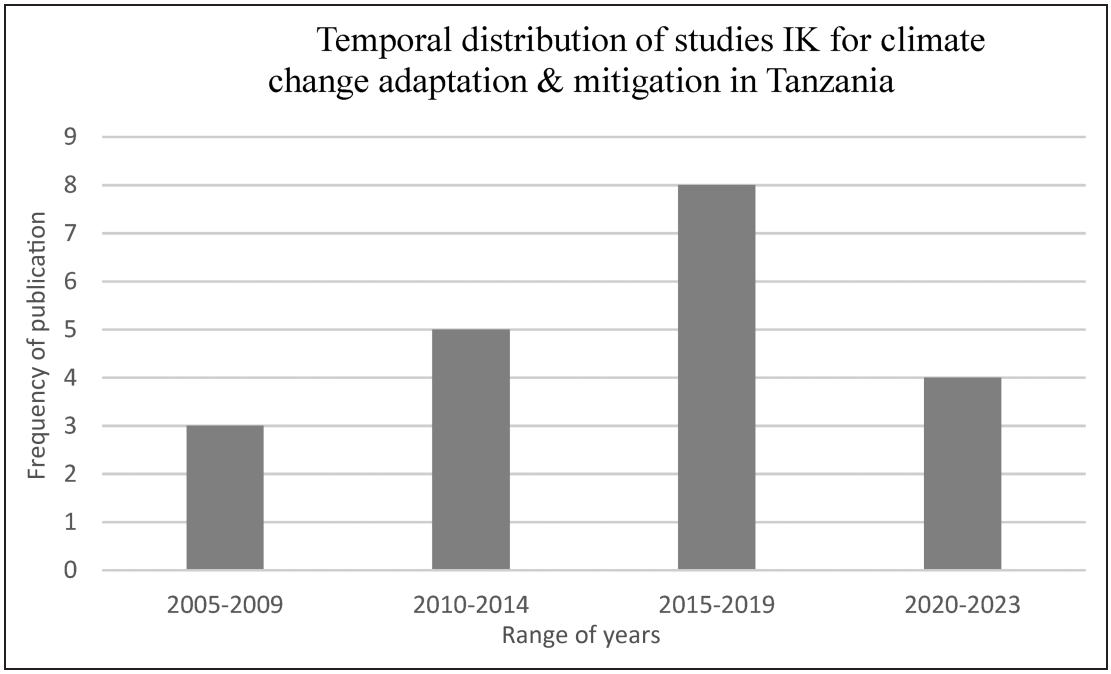

Figure 2. Temporal distribution of studies on Indigenous knowledge for climate change adaptation and mitigation in Tanzania.

publications, including the variables considered and the titles of the articles. Among the 20 peer-reviewed articles, there are differences in the variables used for representing Indigenous knowledge, climate change adaptation and mitigation, and smallholder farmers' practices. The majority of the studies (16, 80%) used mixed methods because of the nature of Indigenous knowledge. A participatory approach is needed to be able to grasp the ideas, concepts and practices used by communities.

Temporal distribution of studies on Indigenous knowledge for climate change adaptation and mitigation in Tanzania.. The review found that the majority of the studies (12, 60%) on Indigenous knowledge for climate adaptation and mitigation were conducted between 2015 and 2023 (Figure 2). However, the number of studies in this area had increased from previous years. This indicates the increasing recognition of the significance of Indigenous knowledge in solving contemporary challenges. It is indicative of a paradigm shift, as Indigenous knowledge has been disregarded as capable of solving contemporary and scientific-based challenges by scientific communities (Makondo and Thomas, 2018).

Geographical focus.. The review found that the studies had been conducted in 10 regions, with the majority in Dodoma (4, 16%) and 3 (12.5%) in Kilimanjaro, Iringa and Morogoro, respectively (Figure 3). However, Tanzania is a country with multiple ethnic groups, which include more than 125 ethnic communities that speak over 120 vernacular languages and live in more than 30 regions (United Republic of Tanzania, 2022). Each ethnic Indigenous community has vast resources of Indigenous knowledge. However, the fact that only 10 regions have been studied shows a significant gap in knowledge with regard to the rest of the regions' Indigenous knowledge and how it is used in responding to climate risk.

Sources used for acquiring and preserving knowledge

The review found that Indigenous knowledge is acquired from various sources, including, but not limited to, personal experience, parents, friends and community members. Elders from previous generations receive and preserve Indigenous knowledge and pass it down to successive generations through oral traditions. The most common practice of obtaining and preserving Indigenous knowledge is community knowledge-sharing, where community members discuss different means used to adapt to climate change through oral traditions and community forums (Theodory, 2020). Information and communications technology tools, such as radio, are also playing a part as sources of Indigenous knowledge among Indigenous communities (Table 1).

The study conducted in the Kagera Region found that the Haya ethic group acquired Indigenous knowledge from their personal experience based on the changes that were occurring in their surrounding

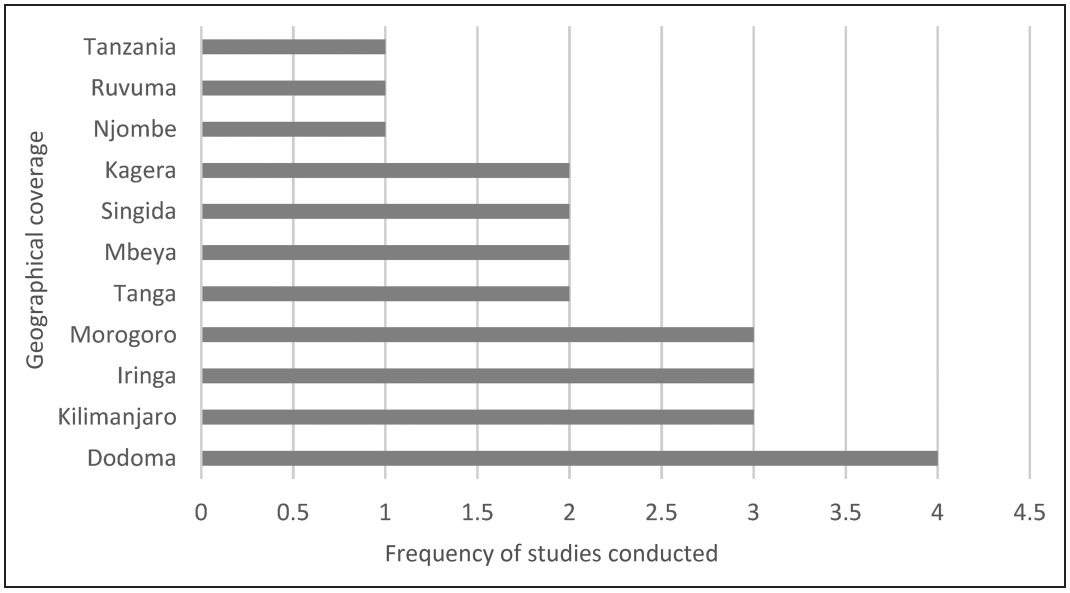

Figure 3. Geographical focus.

environment, such as an outbreak of banana disease (*mnyauko*), which forced them to change their diet (Theodory, 2020). The study conducted in Dodoma by Shemsanga et al. (2018) found that Indigenous knowledge was received from ancestors and passed down to the next generation. This had been useful in determining the sources of shallow water, and hence for survival in semi-arid climatic conditions.

Indigenous communities' perception of climate change

The review found that, based on Indigenous indicators, observation and experience, Indigenous communities in Tanzania perceived the climate to have changed. This claim is consistent with the meteorological data, which shows that the climate in Tanzania has changed over the past decades (Ibrahim, 2014; Mlengule, 2019). Their perception of climate change was justified by the adaptation and mitigation practices that they had employed over time and, more importantly, the practices of creating, preserving and passing down their Indigenous knowledge to the next generation. This shows how deep their understanding is regarding climate change and that climate change is a continuous problem that the future generation must face – hence knowledge is preserved for them (Shemsanga et al., 2018). The study conducted by Kangalawe et al. (2011) in the Mbeya Region found that Indigenous communities perceived that, for the previous 10–30 years, community members showed rainfall has decreased. In Singida, Lema and Majule (2009) found that Indigenous communities indicated that they perceived precipitation to have decreased and temperatures to have increased over the years.

Indigenous climate change indicators and their interpretation

Extended periods of interaction between Indigenous communities and their surrounding environment have resulted in the development of Indigenous knowledge systems with indicators that are capable of identifying climate change, helping people to prepare an appropriate adaptation response. The review found that smallholder farmers used various Indigenous indicators to predict changes. In Kilimanjaro, Chengula and Nyambo (2016) revealed that no shade from trees, *dudumizi* singing in the morning and *ndekrefa* singing in January and February were all signs of the onset of rain. In their study, Elia et al. (2014) revealed that *dudumizi* were also used in Dodoma and Singida as indicators for seasonal weather forecasting (Table 2).

The study conducted by Mahoo et al. (2015) revealed that *dudumizi* were used in Tanga to predict climate change, especially the onset of rainfall. Mlengule's (2019) research in Njombe found that a rise in water level and butterflies moving from west to east were an indication that rain was coming. The appearance of *yangi yangi* birds in large numbers in the sky in the months of October and November indicated imminent rainfall and a good rainy season (Chang'a et al., 2010), and the appearance of red ants in the Morogoro Region also indicated that rain was on the way (Mussa and Mjemah, 2015). Indicators that were used for

Table 1. Sources used to acquire Indigenous knowledge for climate change adaptation and mitigation among smallholder farmers.

Serial Number	Author(s)	Title	Key findings	Study area	Method
1.	Theodory (2020)	Understanding the relevance of Indigenous knowledge on climate change adaptation among mixed farmers in the Ngono River Basin, Tanzania	Sources of Indigenous knowledge were own experience, information shared within the community and family members	Kagera	Qualitative
2.	Mahoo et al. (2015)	Integrating Indigenous knowledge with scientific seasonal forecasts for climate risk management in Lushoto District in Tanzania	Sources of information were own observations, the radio and village meetings Indigenous knowledge often passed on from one generation to the next	Tanga	Mixed
3.	Radeny et al. (2019)	Indigenous knowledge for seasonal weather and climate forecasting across East Africa	Major sources of weather information were Indigenous sources (67.5%) and the radio (61%)	Tanga	Mixed
4.	Lema and Majule (2009)	Impacts of climate change, variability and adaptation strategies on agriculture in semi- arid areas of Tanzania: The case of Manyoni District in Singida Region, Tanzania	Experience Increase in temperature over the last 10 years Decrease in precipitation	Singida	Mixed
5.	Shemsanga et al. (2018)	Indigenous knowledge on development and management of shallow dug wells of Dodoma Municipality in Tanzania	Local people had received/ preserved knowledge from older generations about areas that were drilled many years earlier Trees like *Ficus sycomorus*, *Acacia albida* and *Adansonia digitata* were used for gauging areas with high soil moisture content	Dodoma	Mixed

signalling erratic rainfall and drought were the disappearance of fig mulberry trees (Mussa and Mjemah, 2015) and the angle of the new moon (Chang'a et al., 2010). When the *ndekrefa* (*kichagga*) sang in January and February, or in the middle of a prolonged drought, it was indicative of rainfall (Chengula and Nyambo, 2016).

Indigenous adaptive and mitigation practices for climate change among smallholder farmers

The review found that smallholder farmers had been employing various techniques to help them adapt to and mitigate the impacts of climate change. The strategies included mixed farming practices, with farmers starting to grow several crops on the same farm; crop diversification; traditional water dams; prayer and cultural rituals; participating in non-farming activities, such as driving *boda boda*; entrepreneurship; and the use of locally made pesticides (Theodory, 2020; see Table 3).

The study conducted in Iringa and Kilimanjaro by Kaganzi et al. (2021) revealed that smallholder farmers used various adaptation techniques, including changing their farming methods and animal-keeping practices, as well as diversifying their agricultural activities, with farmers sowing seeds twice in one season when needed. In Ruvuma, smallholder farmers used different adaptation and mitigation techniques, such as Matengo pits and contour terracing to reduce water speed and control soil erosion, and intercropping (Malekela and Lusiru, 2022). In Morogoro, smallholder farmers protected and planted native/natural vegetation to mitigate soil erosion and water speed due to its mountainous environment.

Table 2. Indigenous climate change indicators and their interpretation among smallholder farmers.

Serial number	Author(s)	Title	Key findings	Study area	Method
1.	Elia et al. (2014)	Indigenous knowledge use in seasonal weather forecasting in Tanzania: The case of semi-arid central Tanzania	Use of plant phenology, such as the sprouting of leaves on trees and flowers Bird indicators: appearance of the white-browed coucal (*Centropus superciliosus*), also known locally as the *dudumizi*; cattle egret (*Bubulcus ibis*), locally known as the *yanga yanga*; and wire-tailed swallow Appearance of frogs	Dodoma and Singida	Qualitative
2.	Radeny et al. (2019)	Indigenous knowledge for seasonal weather and climate forecasting across East Africa	Behaviour, appearance and movement of some birds was frequently used to predict seasonal weather Presence of the yellow bird was an indication of long rains	Tanga	Mixed
3.	Kangalawe et al. (2011)	Climate change impacts, local knowledge and coping strategies in the Great Ruaha River Catchment Area, Tanzania	Community members showed that rainfall had decreased over the last 10–30 years Early sprouting of *mihango* trees indicated early onset of rains When the *dudumizi* and *kolekyaka* (birds) started singing, it was interpreted locally to mean the rains were near	Mbeya	Mixed
4.	Ringo et al. (2016)	Indigenous knowledge in flood management and control in Kilosa District, Tanzania	Indigenous knowledge contributed to weather forecasting	Morogoro	Mixed
5.	Kaganzi et al. (2021)	Local perceptions of climate change and adaptation responses from two mountain regions in Tanzania	Modifying farming or animal rearing Diversification of agricultural activities Farmers sowed seeds twice in one season when needed	Iringa and Kilimanjaro	Mixed
6.	Kijazi et al. (2013)	The use of Indigenous knowledge in weather and climate prediction in Mahenge and Ismani wards, Tanzania	83% of the respondents were aware of climate change Plant phenology was found to be the most used indicator to predict rainfall Insects and birds	Morogoro and Iringa	Mixed
7.	Mlengule (2019)	Smallholder farmers' local knowledge in adaptation to climate variability: Experience from Ludewa District, Tanzania	When birds were heard singing 'dudududududu' early in the morning, the water level rose, and butterflies moved from west to east, it was about to rain	Njombe	Mixed
8.	Chengula and Nyambo (2016)	The significance of Indigenous weather forecast knowledge and practices under weather variability and climate change: A case study of smallholder farmers on the slopes of Mount Kilimanjaro	When there was no tree shade in January, the *dudumizi* sang early in the morning, and the *ndekrefa* (*kichagga*) sang in January and February or in the middle of a prolonged drought, rain was about to fall	Kilimanjaro	Mixed
9.	Chang'a et al. (2010)	Indigenous knowledge in seasonal rainfall prediction in Tanzania: A case of the south-western highland of Tanzania	Occurrence of *yangi yangi* birds in October and November indicated imminent onset of rain and a good rainy season Flocks of swallows indicated that heavy rain was about to fall The appearance of swallows in November indicated imminent onset of rain A new moon at a slanted angle indicated more disease and erratic rainfall	Mbeya and Iringa	Mixed
10.	Mussa and Mjemah (2015)	Indigenous knowledge systems for climate change detection and adaption planning in mountainous areas in Tanzania	Disappearance of fig mulberry trees signalled a decrease in precipitation Red ants signalled onset of rain Climate hazards such as floods and droughts	Morogoro	Mixed

Use of traditional prayers, rituals and worship for climate change adaptation and mitigation

African Indigenous communities are famous for their spiritual prayers and forms of worship, which include rituals and cultural practices. The review found that Indigenous communities were involved in seeking help from God in the face of disasters wrought by climate change in various regions of Tanzania; prayers were also said to be effective. For instance, when there is a prolonged drought, Indigenous communities start praying and performing rituals for the drought to end (Fundisha, 2020). The study conducted in Kagera found that Indigenous communities used prayers and worship for assistance in their efforts to adapt to and mitigate climate change. Local communities in Kagera consulted traditional rainmakers *(abaiga enjula*; Theodory, 2020).

Knowledge gap in the use of Indigenous knowledge for climate change adaptation and mitigation

Considering the diverse climatic conditions and experiences in Tanzania's regions and among its

Table 3. Indigenous adaptive and mitigation practices for climate change among smallholder farmers.

Serial number	Author(s)	Title	Key findings	Study area	Method
1.	Kihila (2018)	Indigenous coping and adaptation strategies to climate change of local communities in Tanzania: A review	Strategies included mixed farming, crop diversification and traditional water dams	Tanzania	Qualitative
2.	Theodory (2020)	Understanding the relevance of Indigenous knowledge on climate change adaptation among mixed farmers in the Ngono River Basin, Tanzania	Adaptation and mitigation strategies included planting drought-resistant and early maturing crops, prayers and worship, undertaking non-farming activities, and use of locally made pesticides	Kagera	Qualitative
3.	Naess (2013)	The role of local knowledge in adaptation to climate change	Indigenous weather forecasting to moderate the effects of variable rainfall Use of Indigenous observations in decision-making	Dodoma	Mixed
4.	Malekela and Lusiru (2022)	Climate change adaptation strategies through traditional farming practices: The case of Matengo pits in Mbinga District, Tanzania	Matengo pits are a traditional farming technique Contour terracing Intercropping	Ruvuma	Mixed
5.	Fundisha (2020)	Traditional mitigation measures and practices to climate change in Rombo District, Tanzania	Tree planting Creating awareness of climate change at the local level Avoidance of indiscriminate tree felling Praying	Kilimanjaro	Mixed
6.	Nelson and Stathers (2009)	Resilience, power, culture, and climate: A case study from semi-arid Tanzania, and new research directions	Adoption of early maturing crops like sorghum, and drought-resistant crops	Dodoma	Qualitative
7.	Yanda et al. (2005)	Climatic and socio-economic influences on malaria and cholera risks in the Lake Victoria region of Tanzania	Use of Indigenous medical knowledge Use of local medicines to adapt to climate-associated diseases such as malaria and cholera *Mbilizi*, *Kajule*, *Nkaka*, *Ikintuntumwa* and *Mwarobaini* Pregnant women used local herbs to reduce complications during pregnancy	Kagera	Mixed
8.	Ringo et al. (2016)	Indigenous knowledge in flood management and control in Kilosa District, Tanzania	Steep-slope controlling techniques Planting of native vegetation	Morogoro	Mixed

ethnic groups, Indigenous knowledge is an essential part of ethnic communities' adaptation to climate change and mitigation efforts. There is a significant knowledge gap with regard to Indigenous knowledge use for climate change adaptation in Tanzania for there is limited documentation on the use of Indigenous knowledge in the majority of Tanzania's ethnic groups, communities and regions based on geographical location, cultural practices and environmental conditions. Moreover, the major agro-ecological zones of Tanzania have not yet been studied. This review offers a comprehensive

overview of what has been done with regard to the use of Indigenous knowledge to enhance climate adaptation and mitigation, and the integration of Indigenous and scientific knowledge for climate change adaptation and mitigation among smallholder farmers in Tanzania.

Conclusion

Based on the findings of this study, Indigenous knowledge makes a significant contribution to Tanzanian smallholder farmers' adaptation to climate change. It is significantly related and connected to their environments and traditional practices, and animals, birds, amphibians, plants and changes in the sky are all used to predict change. Community elders play the important role of custodians; family members facilitate knowledge-sharing; and information and communications technologies are useful for the acquisition, sharing and preservation of Indigenous knowledge. Smallholder farmers use mixed farming techniques, traditional water dams/pits for ensuring water supply and locally made pesticides; they also diversify their economic activities. These are the primary knowledge and information resources that farmers have at their disposal. This is facilitated by limited access to scientific knowledge. Tanzanian ethnic communities depend on Indigenous knowledge to adapt to climate change due to its contextual-based nature and its ability to solve contextual-based problems, and it has proven to be effective by its continuous use, being passed down through the generations. In fact, it is in people's nature to cherish and trust what they have inherited from their predecessors. This justifies their trust in the Indigenous practices that they are applying in response to climate adaptation.

Recommendations

Further research is recommended to document the use of Indigenous knowledge for climate change adaptation across all regions and ethnic groups in Tanzania. In addition, research would be helpful on the use of Indigenous knowledge for climate change adaptation and mitigation in the agro-ecological zones and at the national level for policy recommendations and to bridge the gap between Indigenous knowledge, research, policy and scientific knowledge in Tanzania.

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References

Chang'a LB, Yanda PZ and Ngana J (2010) Indigenous knowledge in seasonal rainfall prediction in Tanzania: A case of the south-western highland of Tanzania. *Journal of Geography and Regional Planning* 3(4): 66–72.

Chengula F and Nyambo B (2016) The significance of Indigenous weather forecast knowledge and practices under weather variability and climate change: A case study of smallholder farmers on the slopes of Mount Kilimanjaro. *Agricultural Education and Extension* 2(2): 31–43.

Dorji T, Rinchen K, Morrison-Saunders A, et al. (2024) Understanding how Indigenous knowledge contributes to climate change adaptation and resilience: A systematic literature review. *Environmental Management* 74(6): 1101–1123.

Elia EF, Mutula S and Stilwell C (2014) Use of Indigenous knowledge in seasonal weather forecasting in semi-arid central Tanzania. *South African Journal of Libraries and Information Science* 80(1): 18–27.

Fundisha E (2020) Traditional mitigation measures and practices to climate change in Rombo District, Tanzania. *Journal of Global Resources* 6(2): 10–17.

Ibrahim A (2014) *Gendered analysis of the determinants of adaptive capacity to climate change among smallholder farmers in Meatu and Iramba Districts, Tanzania*.

Irumva O, Twagirayezu G and Nizeyimana JC (2021) The need of incorporating Indigenous knowledge systems into modern weather forecasting methods. *Journal of Geoscience and Environment Protection* 9(2): 55–70.

Joseph LS (2022) Factors that accelerate vulnerability to climate change impact among the agro-pastoralists in Arumeru, Tanzania. *East African Journal of Education and Social Sciences* 3(2): 37–47.

Kaganzi KR, Cuni-Sanchez A, McHarazo F, et al. (2021) Local perceptions of climate change and adaptation responses from two mountain regions in Tanzania. *Land* 10(10): Article 99.

Kangalawe R, Mwakalila S and Masolwa P (2011) Climate change impacts, local knowledge and coping strategies in the Great Ruaha River Catchment Area, Tanzania. *Natural Resources* 2(4): 212–223.

Kihila JM (2018) Indigenous coping and adaptation strategies to climate change of local communities in Tanzania: A review. *Climate and Development* 10(5): 406–416.

Kijazi AL, Chang'a LB, Kanemba A, et al. (2013) The use of Indigenous knowledge in weather and climate prediction in Mahenge and Ismani wards, Tanzania. *Journal of Geography and Regional Planning* 6(7): 274–279.

Kuivanen K, Alvarez S and Langeveld C (2015) *Climate change in southern Africa: Farmers' perceptions and responses. Review report, Farming Systems Ecology*.

Lema M and Majule A (2009) Impacts of climate change, variability and adaptation strategies on agriculture in semi-arid areas of Tanzania: The case of Manyoni District in Singida Region, Tanzania. *African Journal of Environmental Science and Technology* 3(8): 206–218.

Mahoo H, Mbungu W, Yonah I, et al. (2015) *Integrating Indigenous knowledge with scientific seasonal forecasts for climate risk management in Lushoto District in Tanzania*.

Makondo CC and Thomas DSG (2018) Climate change adaptation: Linking Indigenous knowledge with western science for effective adaptation. *Environmental Science and Policy* 88: 83–91.

Malekela AA and Lusiru SN (2022) Climate change adaptation strategies through traditional farming practices. The case of Matengo pits in Mbinga District, Tanzania. *International Journal of Research Publication and Reviews* 3(5): 3023–3033.

Mapfumo P, Mtambanengwe F and Chikowo R (2016) Building on Indigenous knowledge to strengthen the capacity of smallholder farming communities to adapt to climate change and variability in southern Africa. *Climate and Development* 8(1): 72–82.

Mlengule D (2019) Smallholder farmers' local knowledge in adaptation to climate variability: Experience from Ludewa District, Tanzania. *Tanzania Journal for Population Studies and Development* 26(2): 53–76.

Mugi-Ngenga EW, Kiboi MN, Mucheru-Muna MW et al. (2021) Indigenous and conventional climate-knowledge for enhanced farmers 'adaptation to climate variability in the semi-arid agro-ecologies of Kenya. *Environmental Challenges* 5: Article 100355.

Mussa KR and Mjemah IC (2015) Indigenous knowledge systems for climate change detection and adaption planning in mountainous areas in Tanzania. *Journal of Resources Development and Management* 13: 90–98.

Naess LO (2013) The role of local knowledge in adaptation to climate change. *Wiley Interdisciplinary Reviews: Climate Change* 4(2): 99–106.

Nelson V and Stathers T (2009) Resilience, power, culture, and climate: A case study from semi-arid Tanzania, and new research directions. *Gender and Development* 17(1): 81–94.

Nkuba MR, Chanda R, Mmopelwa G, et al. (2021) Indigenous and scientific forecasts on climate change perceptions of arable farmers : Rwenzori Region, western Uganda. In: Filho WL, Oguge N, Ayal D, et al. (eds) *African Handbook of Climate Change Adaptation*. Cham: Springer, 1685–1703.

Pickson RB and He G (2021) Smallholder farmers' perceptions, adaptation constraints, and determinants of adaptive capacity to climate change in Chengdu. *Sage Open* 11(3). DOI: 10.1177/21582440211032638.

Radeny M, Desalegn A, Mubiru D, et al. (2019) Indigenous knowledge for seasonal weather and climate forecasting across East Africa. *Climatic Change* 156(4): 509–526.

Ringo J, Luvinga K, Morsardi L, et al. (2016) Indigenous knowledge in flood management and control in Kilosa District, Tanzania. *International Journal of Marine, Atmospheric and Earth Sciences* 4(1): 1–15.

Schmidt L, Olorisade BK, McGuinness LA, et al. (2021) Data extraction methods for systematic review (semi)automation: A living systematic review. *F1000Research* 10: Article 401.

Shemsanga C, Muzuka ANN, Martz L, et al. (2018) Indigenous knowledge on development and management of shallow dug wells of Dodoma Municipality in Tanzania. *Applied Water Science* 8: Article 59.

Shirima AO, Mahonge CP and Chingonikaya EE (2018) Climate change effects and perceived sustainability of adaptive capacity resources among smallholder farmers in Manyoni District, Tanzania. *Journal of Co-operative and Business Studies* 1(1): 1–10.

Theodory TF (2020) Understanding the relevance of Indigenous knowledge on climate change adaptation among mixed farmers in the Ngono River Basin, Tanzania. *African Journal of Science, Technology, Innovation and Development* 13(1): 51–59.

Tweheyo R, Bamwesigye D, Kiconco M, et al. (2024) Climate change mitigation in southwestern Uganda using Indigenous knowledge. Epub ahead of print 2024.

United Republic of Tanzania (2022) *Country technical notes on Indigenous peoples' issues*.

Yanda PZ, Kangalawe RYM and Sigalla RJ (2005) *Climatic and socio-economic influences on malaria and cholera risks in the Lake Victoria region of Tanzania*.

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